

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) Publication number:

**0 573 135 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(21) Application number: 93300808.8

(51) Int. Cl.<sup>5</sup>: **E21B 10/62**, E21B 10/56,  
B23P 11/00

(22) Date of filing: 04.02.93

(30) Priority: 27.05.92 ZA 923894

(43) Date of publication of application:  
08.12.93 Bulletin 93/49(84) Designated Contracting States:  
AT BE CH DE ES FR GB IE IT LI NL SE

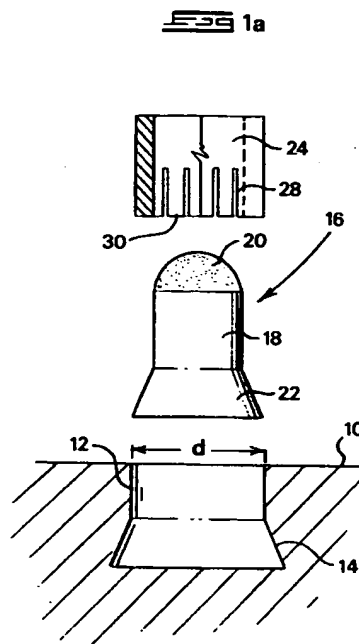
(71) Applicant: **DE BEERS INDUSTRIAL DIAMOND  
DIVISION (PROPRIETARY) LIMITED**  
Debid House,  
Corner Amethyst Street & Crownwood Road,  
Theta  
Johannesburg, Transvaal(ZA)

(72) Inventor: **Jennings, Bernard Alan**  
Plot 53,  
Laezonla  
Johannesburg, Transvaal(ZA)

(74) Representative: **Jones, Alan John et al**  
**CARPMAELS & RANSFORD**  
43 Bloomsbury Square  
London, WC1A 2RA (GB)

(54) **Abrasive tools.**

(57) An abrasive tool such as a drill bit has a body with a working face (10). Undercut recesses (12) are formed in the working face (10). Cutting inserts (16) which present working ends (20) are located in the recesses (12). Locking means (24) in the recesses engage between the undercuts (14) and formations (22) on the inserts (16). This locks the inserts (16) against withdrawal from the recesses (12).

**EP 0 573 135 A1**

## BACKGROUND TO THE INVENTION

THIS invention relates to abrasive tools.

Abrasive tools are known that comprise a body in which are mounted inserts which have a wear-resistant or abrasive layer. It is this layer that is used to perform a cutting or abrading action. The support for the wear-resistant layer may be in the form of a post of squat proportions. It is the mounting of the post in the working face of the tool body that can present problems to the manufacturer and the user. Until now, such posts have been secured to the body by providing a suitable complementally shaped recess or socket in the working face, locating the post therein and brazing the post to the sides of the socket or recess by means of a suitable braze alloy. Most commonly, the post and the recess are cylindrical.

A disadvantage of this method is that residual stresses are induced at the circumferential region of the post at the area where maximum bending stresses also arise in use. These stresses are of the same order of magnitude as the strength of the braze alloy.

Another disadvantage is that the high temperatures required in the brazing cycle tend to cause deterioration of the post, which is usually made of a carbide, and also of the abrasive layer. This is especially so when the abrasive layer is composed of a diamond composite that is not thermally stable.

It may also happen that the impacts to which the tool are subjected in use may cause sufficient rise in temperature to lead to melting of the braze and consequent failure of the bond.

Another method has been to shrink fit the post so that it is mechanically held in the recess or socket. The socket may be suitably tapered with its cross section decreasing with increasing depth into the body.

## SUMMARY OF THE INVENTION

A first aspect of the invention provides an abrasive tool comprising a body having a working face, at least one recess which is formed in the working face and which has at least one side and a wide portion extending beyond the side, a cutting insert which presents a working end and which is located in the recess, and locking means in the recess that engages the wider portion of the recess and the insert, thereby to lock the insert against withdrawal from the recess.

Typically each recess includes an undercut which forms the wider portion.

In preferred versions of the invention, the locking means comprises a deformable locking insert which has been forced into the recess between the

recess and the cutting insert so as to engage between the undercut and the formation on the cutting insert.

In one preferred embodiment, the undercut is conically shaped, the cutting insert has a conically shaped foot portion received in the undercut and the locking means comprises a tubular sleeve forced into a position of engagement between the undercut and the foot.

In another embodiment, the cutting insert includes a relatively enlarged waist, the recess includes an annular undercut and the locking means comprises a tubular sleeve forced into a position of engagement between the undercut and the waist.

In yet another embodiment, the cutting insert includes a laterally projecting portion, the recess includes a lateral enlargement and the locking means comprises a strip insert forced into a position of engagement between the laterally projecting portion and the lateral enlargement. In this case, the recess may include a groove in its side wall serving as a keyway for the laterally projecting portion of the cutting insert.

Each of the embodiments summarised above may comprise anti-rotation means to prevent rotation of the cutting insert in the recess. Typically, the anti-rotation means comprises a key on the cutting insert and a keyway in the recess, or vice-versa.

Another aspect of the invention provides a method of securing a cutting insert to the working face of an abrasive tool which has an undercut recess for receiving the cutting insert, the method comprising the steps of:

- a) inserting, into the undercut recess, a cutting insert which has a lateral formation thereon, and
- b) engaging locking means between the undercut and the lateral formation of the cutting insert, thereby to lock the cutting insert against withdrawal from the recess.

Step b) may comprise locating a deformable locking insert between the cutting insert and the recess and causing the locking insert to deform into a position of engagement between the undercut and the lateral formation of the cutting insert. Conveniently, the locking insert is in the form of a tubular sleeve and the locking insert is caused to deform into the position of engagement by application of force thereto using a tubular punch.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings.

In the drawings:

**Figures 1a and 1b**

show exploded and assembled sectional side

views respectively of a portion of an abrasive tool of the invention;

**Figure 2**

illustrates a second embodiment of the invention in a partially exploded view;

**Figures 3a and 3b**

show views corresponding to those of Figure 1 but of a third embodiment of the invention;

**Figures 4a and 4b**

show views corresponding to those of Figure 1 but of a fourth embodiment of the invention; and **Figure 4c**

shows a view looking in the direction of the arrow in Figure 4b.

### DESCRIPTION OF EMBODIMENTS

This invention has particular application to drill bits wherein the inserts are studcutters. The studcutter may be any one of various shapes in cross section, including but not limited to square, oval or rectangular or even combinations thereof.

The working end may be of various shapes from flat cylindrical to oval or bullet-shaped and may contain indentations or be discontinuous.

The recesses shaped to accommodate the studcutter may be cast in the working surface of the drill crown or may be machined using a dovetail cutter in a milling machine, such as a CNC (computer numerically controlled) milling machine. Alternatively, round undercut holes may be made with a conventional adjustable boring head fitted to any suitable milling machine.

A first embodiment of the invention will now be described with reference to Figures 1a and 1b of the drawings.

With reference to Figure 1a, the working face 10 of a drill crown contains a recess 12 which has been undercut to form a flared, in this case conically shaped portion 14 of expanded cross section. At the working face 10, the recess 12 has a diameter of dimension d. A studcutter 16 has a post with a cylindrical portion 18, carrying an abrasive working end 20, and a conically shaped foot 22 at the other end. The diameter of the foot is no larger than the diameter d and is preferably slightly less.

In assembling the drill bit, the studcutter 16 is located in the recess 12, foot first, so that the foot 22 locates in the flared portion 14 of the recess. It will be noted that the relative dimensions of the recess and of the studcutter post are such that a vacant space is left between the studcutter post 18 and the walls 26 of the recess.

Thereafter, a deformable sleeve 24 is positioned around the studcutter and is forced axially into the recess 12. With the application of sufficient force, the lower portion of the sleeve 24 is caused to expand around the foot 20 of the studcutter. In

practice, force is applied to the sleeve by means of a tubular punch which presses against the upper edge of the sleeve and drives the sleeve in a direction into the recess 12.

To facilitate expansion of the lower portion of the sleeve 24, saw cuts 28 are formed in the wall of the sleeve from its leading end 30. The sleeve material will typically be a relatively pliable material such as mild or stainless steel or a plastics material, so that it can be made to deform in a manner to conform to the shape of the space existing between the wall of the recess and the studcutter post.

The studcutter assembly is shown in assembled form in the working face of the drill bit in Figure 1b. The lower portion of the sleeve 24 has expanded to surround the foot 22 of the studcutter 16 and occupy the undercut, flared portion 14 of the recess 12.

In this position, the sleeve 24 serves to lock the studcutter in the working face 10 with its working end 20 exposed and standing proud of the working face. Any force exerted applied to the studcutter in a direction to pull it from the drill crown will result merely in forces, indicated by the arrows in Figure 1b, being applied to the wall of the recess. The wall 26 exerts opposing forces on the studcutter and sleeve, thereby locking them in position in the recess.

The studcutter secural method illustrated by Figures 1a and 1b was tested in the laboratory for impact and torque resistance. The test for impact resistance was performed using a standard Izod impact tester made by Avery. Using the Izod tester, a pendulum-suspended impactor chisel was swung transversely so as to impact against the upstanding portion of the studcutter post. In each case, the studcutter post was machined to have a flat surface against which the corresponding flat surface of the impactor chisel could strike fully. The pendulum was given 300J of kinetic energy for each blow against the cutter post.

Three conventional brazed assemblies were tested alongside four assemblies according to Figures 1a and 1b and measurements were made of the energy required to break the studcutter post. The post of the three conventional assemblies broke on absorption of 18J, 22J and 23J respectively. Of the four assemblies of the present invention, two of the posts fractured at 47J and 110J respectively. Even though impacted twice, the other two posts could not be broken at all, indicating that these posts could twice absorb the full 300J of available energy without fracture.

Overall it was clear that studcutter posts secured in accordance with the technique proposed in Figures 1a and 1b showed a far higher impact resistance than the conventionally brazed studcut-

ter posts.

Torque resistance tests were performed using a torque wrench with a suitable adaptor to engage the studcutter post, and measurements were made of the torque required to rotate the post in its mounting.

In a test on a conventionally brazed studcutter post, no rotation was observed at a torque of 450Nm. In a corresponding test on a studcutter post mounted in accordance with Figures 1a and 1b, rotational slippage was observed at 140Nm. This indicated the desirability of anti-rotation devices in the technique of Figures 1a and 1b if high levels of torsional resistance are considered necessary.

A second embodiment of the invention is shown in Figure 2. In this case, the studcutter 16 has a post 18 with an end section 22 and a reduced diameter neck section 32. In practice, the illustrated shape is achieved by appropriate machining of the cylindrical post of a conventional bullet-shaped studcutter. Collets 34 are secured to the post 18 in the region of the neck section and create a flared foot for the post as illustrated. The collets may be secured in the illustrated positions by means of a suitable adhesive.

The embodiment of Figure 2 is then secured in a recess in the working face of a tool by means of a sleeve like the sleeve 24 used in the first embodiment. As before, the studcutter is therefore locked against withdrawal from the recess. Once again, it is anticipated that anti-rotation measures will be required if high levels of torsional resistance are to be provided.

A third embodiment of the invention is illustrated in Figures 3a and 3b. Referring to these Figures, the post of a studcutter 40 has a thickened waist portion 42 between its end 44 and the abrasive working end 46. The recess 48 in the working face 50 of a drill bit has a similar shape.

In use, the studcutter post is inserted into the recess 48 and an expandable sleeve 52, similar to the sleeve 24 of the first embodiment, is then forced into position around the post 40 and the thickened waist portion 42 to lock the studcutter post in the recess.

As in previous embodiments, it is expected that anti-rotation measures will be necessary if high levels of torsional resistance are to be provided.

A fourth embodiment of the invention is illustrated by Figures 4a, 4b, and 4c. Referring to these Figures, a studcutter 60 has a post 62 having an abrasive working end 64. Close to the opposite end 66 is a projection 68. A recess 70 formed in the working face 72 of a drill bit includes an enlargement or "bubble" 74 formed at its lower end. The bubble 74 is shaped to accommodate the projection 68 on the post 62. A groove 76 extends from

the working face 72 to the bubble 74.

In use, the studcutter post 62 is inserted into the recess 70. During the insertion process the groove 76 acts as a keyway to guide the projection 68 into the bubble 74. Thereafter a strip insert 78 is forced down the groove 76 and around the projection 68, as shown in Figure 4b, to lock the studcutter post in the recess.

In this embodiment, the engagement between the projection 68 and the bubble 74, via the insert 78, acts to prevent rotation of the studcutter post in the recess. Thus this embodiment can be expected to have a higher torsional resistance than the earlier embodiments.

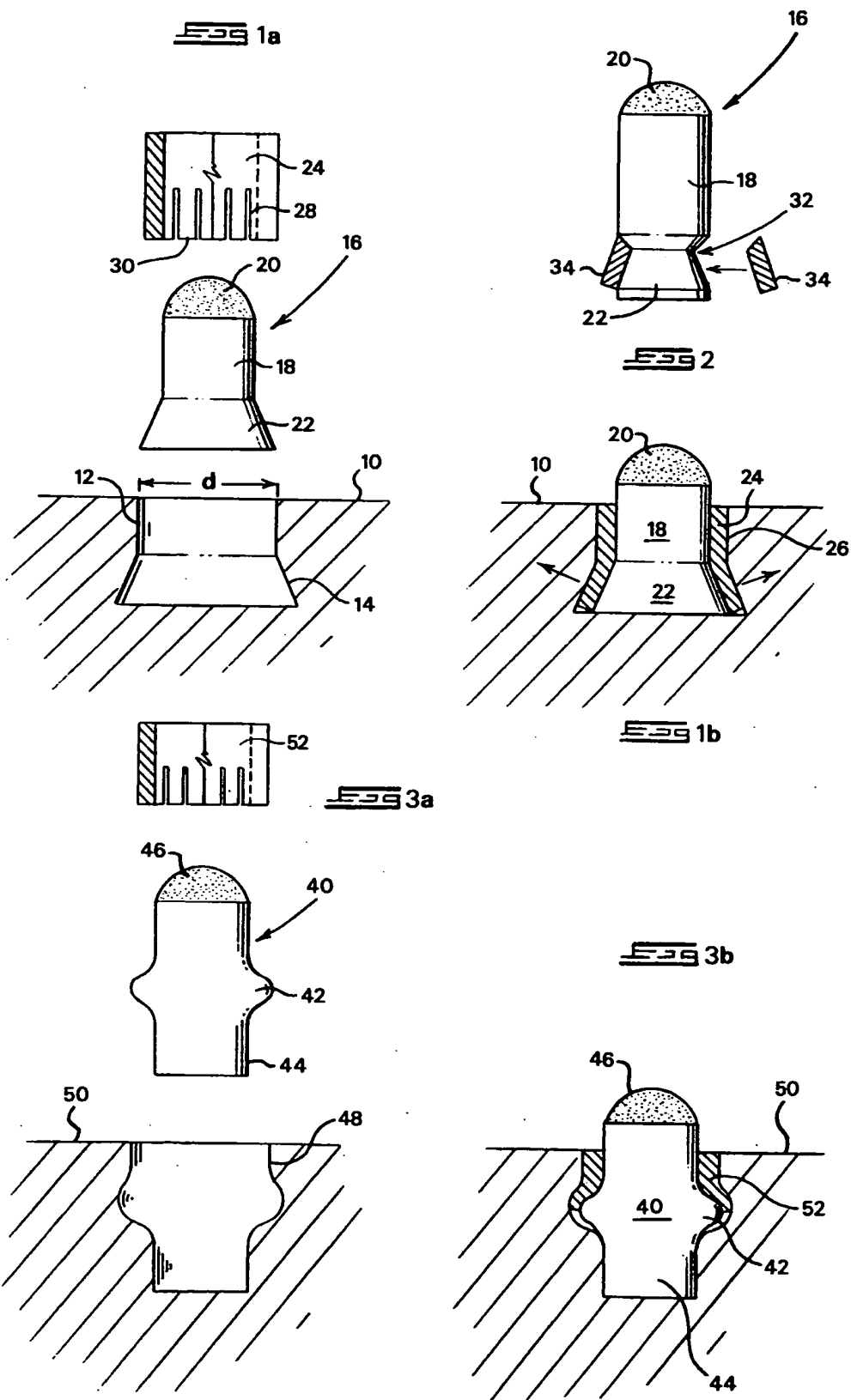
It will be appreciated that it would be a simple matter to include an anti-rotation device of the type illustrated in Figures 4a to 4c in the embodiments described previously, or in fact other anti-rotation measures, if high levels of torsional resistance are necessary in a particular application.

Note that the exposed top surface of the sleeve or strip in the relevant embodiments can be provided with an abrasive protective layer. Note also that the abrasive working end of each cutting insert is preferably provided by a diamond compact.

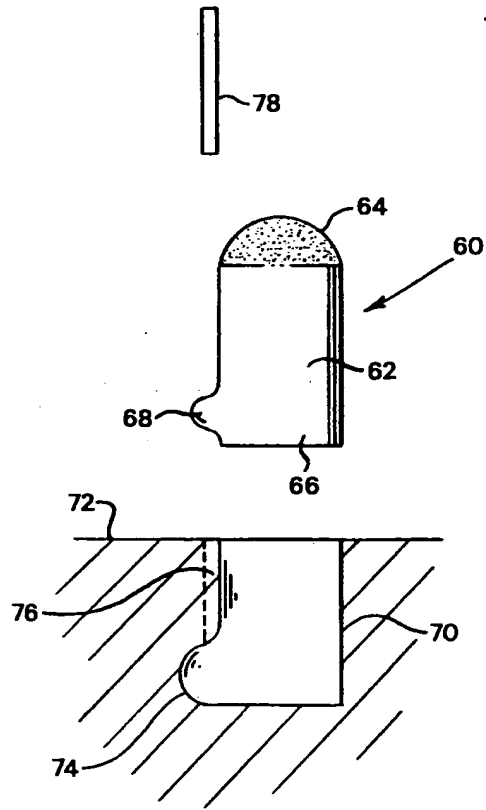
#### Claims

1. An abrasive tool comprising a body having a working face (10, 50, 72), at least one recess (12, 48, 70) and a cutting insert (16, 40, 60) which presents a working end (20, 46, 64) and which is located in the recess (12, 48, 70), characterised in that the recess (12, 48, 70) has at least one side with a wider portion (14, 74) extending beyond the side, and in that locking means (24, 52, 78) in the recess engage the wider portion (14, 74) of the recess (12, 48, 70) and the insert (16, 40, 60), thereby to lock the insert (16, 40, 60) against withdrawal from the recess (12, 48, 70).
2. An abrasive tool according to claim 1 characterised in that each recess (12, 48, 70) includes an undercut which forms the wider portion (14, 74).
3. An abrasive tool according to claim 2 characterised in that the locking means (24, 52, 78) comprises a deformable locking insert which has been forced into the recess (12, 48, 70) so as to engage between the undercut (14, 74) and a formation (22, 34, 42, 68) on the cutting insert (16, 40, 60).
4. An abrasive tool according to claim 3 characterised in that: the undercut (14) is conically shaped, the cutting insert (16) has a conically

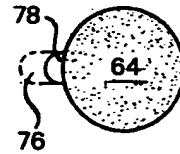
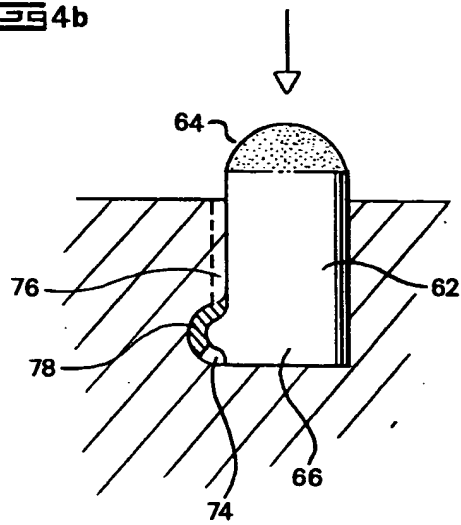
- shaped foot portion (22) received in the undercut (14), and the locking means comprises a tubular sleeve (24) forced into a position of engagement between the undercut (14) and the foot portion (22).
5. An abrasive tool according to claim 4 characterised in that the conically shaped foot portion (22) of the cutting insert (16) is enlarged relative to the remainder (18) of the cutting insert (16). 5
  6. An abrasive tool according to claim 3 characterised in that: the cutting insert (40) includes a relatively enlarged waist (42), the recess (48) includes an annular undercut, and the locking means comprises a tubular sleeve (52) forced into a position of engagement between the undercut and the waist (42). 10
  7. An abrasive tool according to claim 3 characterised in that: the cutting insert (60) includes a laterally projecting portion (68), the recess (70) includes a lateral enlargement (74), and the locking means comprises a strip insert (78) forced into a position of engagement between the laterally projecting portion (68) and the lateral enlargement (74). 15
  8. An abrasive tool according to claim 7 characterised in that the recess (70) includes a groove (76) in its side wall serving as a keyway for the laterally projecting portion (68) of the cutting insert (60). 20
  9. An abrasive tool according to claim 1 characterised in that it comprises anti-rotation means (68, 74, 76) to prevent rotation of the cutting insert (60) in the recess (70). 25
  10. An abrasive tool according to claim 9 characterised in that the anti-rotation means comprises a key (68) on the cutting insert (60) and a keyway (76) in the recess (70), or vice-versa. 30
  11. An abrasive tool according to claim 4 characterised in that the sleeve (24) has a tubular wall with slots (28) cut into one end thereof. 35
  12. An abrasive tool according to claim 6 characterised in that the sleeve (24) has a tubular wall with slots (28) cut into one end thereof. 40
  13. An abrasive tool according to claim 1 characterised in that each cutting insert (16, 40, 60) comprises a post (18, 44, 62) carrying an abrasive element (20, 46, 64) at its working end and at least one relatively enlarged formation (22, 34, 42, 68) thereon at a position spaced from the working end. 45
  14. An abrasive tool according to claim 13 characterised in that the abrasive element (20, 46, 64) is a diamond compact. 50
  15. An abrasive tool according to claim 1, characterised in that the tool is a drill bit. 55
  16. A method of securing a cutting insert (16, 40, 60) to the working face (10, 50, 72) of an abrasive tool which has an undercut recess (12, 48, 70) for receiving the cutting insert (16, 40, 60), the method being characterised by:
    - a) inserting, into the undercut recess (12, 48, 70), a cutting insert (16, 40, 60) which has a laterally projecting formation (22, 34, 42, 68) thereon; and
    - b) engaging locking means (24, 52, 78) between the undercut (14, 74) and the laterally projecting formation (22, 34, 42, 68) of the cutting insert (16, 40, 60), thereby to lock the cutting insert (16, 40, 60) against withdrawal from the recess (12, 48, 70).
  17. A method according to claim 16 characterised in that step b) comprises locating a deformable locking insert (24, 52, 78) between the cutting insert (16, 40, 60) and the recess (12, 48, 70) and causing the locking insert (24, 52, 78) to deform into a position of engagement between the undercut (14, 74) and the lateral formation (22, 34, 42, 68) of the cutting insert (16, 40, 60).
  18. A method according to claim 17 characterised in that the locking insert is in the form of a tubular sleeve (24) and the locking insert is caused to deform into the position of engagement by application of force thereto using a tubular punch.



**FIG 4a**



**FIG 4b**



**FIG 4c**



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

EP 93 30 0808

Page 1

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 749 190 (SHIPMAN)	1-3,13,15-18	E21B10/62 E21B10/56 B23P11/00
Y	* column 1, line 48 - line 62 *	4-6,11,12,14	
X	GB-A-707 021 (AKTIEBOLAGET SVENSKA KULLAGERFABRIKEN)	1,2,9,15	
Y	* page 2, line 29 - line 39; figure 1 *	4-6	
Y	US-A-3 540 537 (BROWN)	11,12	
Y	* column 2, line 74 - column 3, line 7 *	14	
Y	EP-A-0 032 428 (DRILLING & SERVICE U.K. LIMITED)		
Y	* the whole document *		
X	US-A-4 271 917 (SAHLEY)	1-3,9,10,15	
Y	* column 3, line 17 - line 20 *		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
Y	* column 3, line 34 - line 61 *	7,8	E21B B23P
Y	* column 4, line 45 - line 63 *		
X	US-A-4 445 580 (SAHLEY)	1,2,9,13,15,16	
Y	* column 7, line 37 - line 53 *	7,8	
X	US-A-2 628 821 (ALEXANDER)	1,2,9,10,13,15,16	
Y	* column 3, line 56 - column 4, line 53 *		
X	DE-A-3 637 456 (WEZEL)	1,2,9,10,15	
Y	* column 4, line 6 - line 17 *		
	--- -/--		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 SEPTEMBER 1993	Examiner SOGNO M.G.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family, corresponding document	





European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

EP 93 30 0808

Page 2

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	GB-A-448 821 (WALLRAMIT HANDEL MAATSCHAPPIJ) * page 1, line 72 - line 99; figure 2 *	1,2,9	
A	US-A-2 575 438 (ALEXANDER)		
A	US-A-3 006 424 (DAHLIN)		
A	FR-A-2 609 750 (VENNIN)		
A	US-A-3 805 364 (GARDNER)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 SEPTEMBER 1993	Examiner SOGNO M.G.
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons @ : member of the same patent family, corresponding document	